THE UNIVERSITY OF ALBERTA

A PREDICTIVE MODEL FOR STUDENTS ASSISTANCE

by

© LEONA ANDERSON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

FALL, 1970

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled, "A Predictive Model for Students Assistance", submitted by Leona Anderson in partial fulfilment of the requirements for the degree of Master of Education.

ABSTRACT

The study investigated the feasibility of providing a quick and efficient method of assessing students' applications for financial assistance. Three methods of judgement were examined: two models -- a multiple regression equation and a configural model, both of which may be used to predict assistance mechanically -- and the subjective judgment of the assessor. Two criterion variables were compared between models, the ratio of grant to total aid and total aid.

The assessor's subjective judgment and the multiple regression equation were both used to rank predictor variables. Spearman's coefficient of rank correlation revealed an association between the two forms of judgment that approached but did not attain significance.

The nature of the models required that somewhat different techniques be used for measuring their predictive efficiency. The regression model was consistent in predicting a slightly higher percentage of the criterion than did the configural model. Only once was this difference significant (8.77%). The regression model predicted the total aid criterion best with a predictive efficiency of 78.41% which was 3.04% higher than the corresponding prediction made by the configural model.

The results suggest that the mechanical appraisal of applications is feasible under predetermined and well structured conditions using the more readily adaptable configural model.

ACKNOWLEDGMENTS

The author wishes to express her sincere thanks to the members of her committee, Dr. D. C. Fair, Dr. T. O. Maguire, and Dr. J. J. Bergen, for their assistance in the preparation of this thesis. Appreciation is also expressed to the Students Assistance Board, Department of Education, for making the study possible and to D. Flathman and D. Precht in the Division of Educational Research, Faculty of Education, for their work in programming.

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CHAPTER I

Introduction

As nations strive for excellence, it would appear that an individual develops into a contributing member of society primarily by means of education of high quality. In Canada today both elementary and secondary education are free to the individual and generally available. Post-secondary education, although still requiring the payment of tuition fees, is viewed less as a privilege of the middle and upper socio-economic classes, and more as an opportunity to be made available to all those who can benefit from it.

The anticipated enrolment in Canadian universities and colleges for 1975-76 is four times what it was in 1960-61. The operating costs per student are expected to be more than double for the same period (Bladen, Dugal, McCutcheon, & Ross, 1965, p. 32). In Alberta the number of post-secondary students receiving government assistance from 1963-64 to 1967-68 has more than doubled (Figure 1); the amount of assistance received during the same period in the form of awards and loans has increased more than five times. Such a rapid increase in both the number of applicants and the amount of assistance given will, by its sheer mass, present problems in the prompt processing of applications which are presently examined and evaluated individually by Students Assistance Board assessors in the Department of Education.

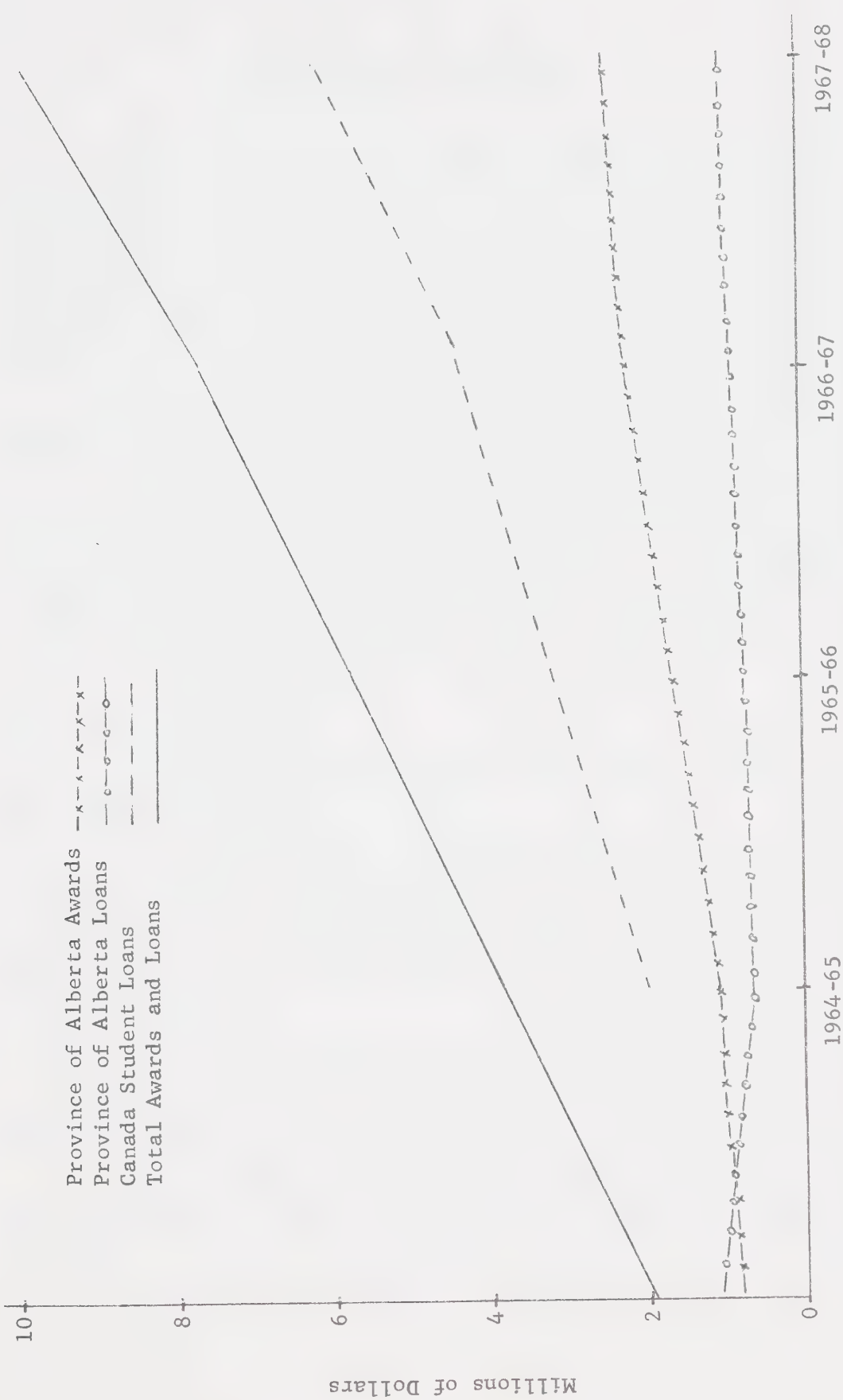

Figure 1. Awards to Students during the Fiscal Years 1963-64 to 1967-68 Inclusive

Purpose of the Study

The purpose of the present study is to investigate the relative predictive value of two forms of judgment, linear and configural, with a view to providing an alternative to the judgment of the assessors in their application of policy. In addition to the possible theoretical value of the study, it is hoped that it may yield some practical benefits. An attempt will be made to develop a predictive model that may be programmed into a computer and thus facilitate the assessment of applications for students' financial assistance. Such a model will be so constructed that it may be readily adapted to incorporate changes in the policy of the Students Assistance Board.

Sub-problems that evolve from specific aspects of the main problem are:

1. To determine the factors used in the routine application of Students Assistance Board policy in order to arrive at the amount and kind of financial assistance awarded to a student.

2. To determine the relative importance of the foregoing factors as predictors of financial assistance.

3. To identify factors that determine whether an applicant should receive other than routine consideration.

Limitations of the Study

1. This study has been limited to the examination of the data of a selected group of aid-receiving undergraduate students enrolled in the four largest faculties of the University of Alberta, namely, Education, Arts, Science, and Engineering.

2. It is the policy of the Students Assistance Board to award grants on the basis of need, and to specify a number of negative factors that may reduce these grants. The presence and interaction of many of these factors necessitates a subjective appraisal of the application. Certain negative factors therefore cannot be included in the proposed prediction model.

3. There is an implicit assumption that the individual assessment of applications is valid. Its use over a period of years has proven it to be workable.

Definition of Terms

Assistance: For the purpose of this study, assistance is the word used to designate financial help. It may be used interchangeably with aid.

Bursary: A bursary is non-repayable assistance given to a student who has reached a designated level of achievement and has demonstrated financial need (Pike, p. 1). Some bursaries impose an obligation on the recipient.

Configural judgment: Configural judgment is the assessors' judgment used in appraising the effects and interactions of factors found in a student's application.

Grant: A grant is non-repayable assistance awarded to a student who demonstrates financial need.

Scholarship: A scholarship is an award given without assessment of financial need, to a student of superior academic standing (Pike, p. 1).

Loan: A loan is assistance given to a student who demonstrates financial need on the understanding that the money will be repaid subsequent to the completion or termination of his studies (Pike, p. 1).

Standard budget: A standard budget is a predetermined amount of money considered sufficient for a student's total expenses over a specified period of time. Various factors will affect the amount, for example, the student's marital status or his academic program.

Negative factors: Negative factors are factors that indicate that a student's funds are not being used efficiently, for example, poor savings from summer earnings or the purchase of a car.

Configural model: A configural model is a system of mathematical relationships in which the judgment or prediction made is a direct function of the variables. The judgment depends upon the pattern of the set of relationships that is being investigated.

Linear model: A linear model is a system of mathematical relationships in which the judgment or prediction is the sum of weighted variables, the weights being calculated to minimize the error of prediction.

Rationale for the Hypotheses

It can be stated with a reasonable degree of certainty that most students applying for financial assistance have their needs met by a routine application of the prevailing policy. The policy was developed through use and periodically modified to meet current demands. It thus became workable for the majority of applicants.

An examination of a random sample of 1075 files showed that 9.7% of the male students and 7.2% of the female students required additional assistance following routine assessment of their applications (Table 1). In the majority of cases circumstances requiring additional funds did not exist when the initial application was made. The most frequent reasons for second requests were:

1. Parental contribution was reduced or not given at all due to business losses or illness.

2. The student has unexpected personal expense, e.g., dental work, glasses, or an automobile accident.

3. A relatively minor reason for requiring additional assistance was that the student had requested less than the standard budget allowed and found that the amount was insufficient for his needs.

TABLE 1

PROPORTIONS AND PERCENTAGES OF A STRATIFIED SAMPLE[a] FROM THE FACULTIES OF EDUCATION, ARTS, SCIENCE, AND ENGINEERING REQUIRING ADDITIONAL FINANCIAL AID IN 1967-68

Faculty	Male					Female					Total				
	1st year	2nd year	3rd year	4th year	Total	1st year	2nd year	3rd year	4th year	Total	1st year	2nd year	3rd year	4th year	Total
Education	6/53	1/41	2/45	6/44	15/183	9/99	2/85	5/63	5/40	21/287	15/154	3/126	7/108	11/84	36/472
	11.1%	2.2%	4.4%	13.7%	8.2%	9.1%	2.1%	7.9%	12.5%	7.1%	9.7%	2.4%	6.5%	13.1%	7.6%
Arts	4/41	6/41	6/45	1/6	17/133	5/48	2/38	3/39	0/4	10/129	9/89	8/79	9/84	1/10	27/262
	9.7%	14.6%	13.3%	16.7%	12.8%	10.4%	5.3%	7.8%	-	7.8%	10.1%	10.1%	10.7%	10.0%	10.3%
Science	6/57	2/40	6/38	0/13	14/148	0/21	0/9	1/9	1/4	2/43	6/78	2/49	7/47	1/17	16/191
	10.5%	5.0%	15.8%	-	9.5%	-	-	11.1%	25.0%	4.6%	7.7%	4.1%	14.9%	5.9%	8.3%
Engineering	8/54	3/38	3/31	0/28	14/151	0/1	-	-	-	0/1	8/55	3/38	3/31	0/28	14/152
	14.8%	7.9%	9.7%	-	9.3%	-	-	-	-	-	14.5%	7.9%	9.7%	-	9.2%
Total	24/205	12/160	17/159	7/91	60/615	14/169	4/132	9/111	6/48	33/460	38/374	16/292	26/270	13/139	93/1075
	11.7%	7.5%	10.7%	7.7%	9.7%	8.3%	3.0%	8.1%	12.5%	7.2%	10.2%	5.5%	9.6%	9.4%	8.7%

[a]The sample is stratified as to sex, faculty, and year of program.

The assessors recognize that the application of current policy will not be equally reliable in predicting the needs of all applicants. They provide for extenuating circumstances by departing from standard policy and giving individual consideration to applicants who, in their judgment, require it. For example, the age of the applicant would likely exempt a girl of seventeen from the necessity of furnishing a specific amount of summer savings for her budget, particularly if her home is in a rural area where employment is not readily available.

From the foregoing example it may be seen that the factors which prescribe individual assessment are not directly additive, but interact with other variables, and thus would affect the reliability of a routine prediction for that individual. Ghiselli (1963) found that these factors which he terms "moderators" cause individual differences in the error of measurement, and as a consequence, in the error of predictability.

The major concern of the present study is to construct a reliable prediction model that will serve most students, and at the same time ensure individual assessment for those who require it. In addition, the feasibility of using this model mechanically will be determined. Current stress on mechanization appears to have created the impression that the computer is the most efficient vehicle for executing tasks of a mathematical nature. While it must be acknow-

ledged that the speed and accuracy of the computer make it invaluable for problems involving extensive calculation, it must also be recognized that there may be limitations to its usefulness. Similarly, clinical judgment may have restricted usage in making predictions and selections effectively.

Meehl (1954) states, "There is no convincing reason to assume that explicitly formalized mathematical rules and the clinician's creativity are equally suited for any given kind of task, or that their comparative effectiveness is the same for different tasks." More specifically, then, the problem is to determine if apparently routine predictions can be effectively made by the more rapid statistical approach, freeing the clinicians -- the assessors in the present study-- to deal with those applications requiring subjective appraisal.

Meehl points out (p. 25) that a variable occurring too infrequently to be statistically significant might materially affect the prediction for the individual it concerns. With reference to the subject under discussion, the mechanical processing of the applications that require individual consideration may result in faulty prediction and consequent inconvenience to the applicant if he should find it necessary to appeal the assessment.

The applications for financial assistance obtain specific information from each applicant, some of which is used for the purpose of identification and is not directly related to the amount and kind of assistance given to the

student. Other items of information provide the basis for awarding assistance. For the purpose of this research both kinds of information were examined in an attempt to identify the factors determining the needs of a selected portion of the student population.

The sample was drawn randomly and consisted of male and female students in the first four years of Education, Arts, Science, and Engineering with single marital status. Married students were not included for they form a relatively small subgroup, and their applications often require special consideration. To ensure the inclusion of only those students whose requests for aid may be dealt with routinely, the following applicants were excluded:

1. Students who were married, separated, or divorced.
2. Students attending Expo or taking holiday trips that would interfere with their earnings or reduce their savings.
3. Students owning an expensive car or purchasing a car during the current year.
4. Students receiving additional assistance following the initial assessment.
5. Students requesting special consideration in the amount or kind of assistance awarded to them due to a wide range of extenuating circumstances, if these conditions were considered valid reasons by the assessors. Requests of this nature usually require a supportive statement from a

counselor or an awards officer.

The following factors were considered with regard to their relative importance in determining a student's financial need:

1. Sex
   (a) male
   (b) female
2. Home location
   (a) Edmonton or Calgary
   (b) Small city or town
3. Age
   (a) Under 21 years
   (b) 21 years and over
4. Faculty
   (a) Education
   (b) Arts
   (c) Science
   (d) Engineering
5. Year of program
   (a) First year
   (b) Second year
   (c) Third year
   (d) Fourth year
6. Ratio of student contribution to student earnings
7. Ratio of parental contribution to required parental contribution
8. Income from other sources, for example, gifts or awards from private organizations

The Hypotheses

The hypotheses are based upon the preceding factors as determinants of the financial need in the population specified. The dependent variable, that is, the variable to be predicted, is in all cases the ratio of grant to total assistance (grant plus loans). The level of correlation in Hypotheses 1 and 3 should reach at least 0.90 for adequate prediction.

1. There is a high correlation between the judgments of the multiple regression equation and the judgments of the Students Assistance Board assessors.

2. There is a significant association, at the .05 level, between the predictive efficiency of the multiple regression equation and that of configural judgment.

3. There is a high correlation between the judgments of the configural model and the judgments of the Students Assistance Board assessors.

4. There is a significant difference between the predictive efficiency of the configural model and that of the multiple regression equation.

CHAPTER II

Review of Related Literature

Current technological advances require the understanding and support of a well-informed public for their effective use and continued development. Post-secondary education is thus becoming increasingly important to a rapidly growing student body. Its financing is a significant factor in government budgets; the equitable distribution of funds for its financing is a matter of concern to student and taxpayer alike.

Canadian Studies

There appear to have been relatively few studies made of public financial assistance to students in Canadian post-secondary institutions. The members of the Bladen Commission in their report to the Association of Universities and Colleges in Canada predict a substantial rise in costs of financing education due to an anticipated increase both in enrolment and in cost per student. They forsee that the average aid required per student will rise from $600 in 1967 to $700 in 1975-76.

The Commission recommends a rising proportion of repayable aid, from 30% in the first year when personal investment is considered "most risky" to 40% in the second year and 50% in the third and subsequent years (Bladen et al., 1965). Using this scale and the present average assistance

of $600, while providing a student with $2400 over a four-year period, would accumulate a debt of $1020.

The Canadian Union of Students in their brief to the Bladen Commission label the Commission's recommendations "overly restrictive." They express dissatisfaction with present policies for financing assistance, but give no evidence that any survey has been made among their members, or any other student groups, to obtain these expressions of opinion.

Their brief recommends that parents not be made responsible for a contribution to the post-secondary education of their children, for it is the student and society that benefit, and therefore it is they who should pay. The nature and extent of the student's responsibility is not specified, but it is suggested that the earnings foregone while he obtains his post-secondary education, and the increased income tax he will pay constitute his contribution. The brief further recommends that the means test be discontinued, that a policy based upon loans only be rejected, and that fees be reduced or eliminated.

R. M. Pike, in his study of student financial aid in Canada (April, 1968), reports that approximately 35% of all post-secondary students received government loans in 1966-67. He estimates a 76% increase in government loans for undergraduate enrolments for the same period of 27%. Total aid to undergraduates increased an estimated 66%.

Pike's examination of the student-aid programmes of the provinces revealed that "...the national distribution of non-repayable aid given in this country is really most inequitable." He found that the student aid programmes of Quebec, Newfoundland, Ontario, and Alberta were "fairly generous" in providing non-repayable aid, while by contrast, the only public financial aid available in Prince Edward Island is repayable through the Canada Student Loans Plan.

In conclusion Pike states "...if we encourage students to attend university, then we (or governments) have the primary responsibility of ensuring that they are able to attend." He recommends that need should come before merit in provincial or federal aid programmes and that rather than awarding merit-based scholarships, "public expenditure is better invested in assuring that no student with financial need is barred, on that account, from attending university." (Pike, p. 5).

American Studies

American studies reveal two main trends in providing student assistance. On the assumption that the disadvantaged student requires more encouragement and support than one from a higher socio-economic group, it is suggested that he be identified and provided with more non-repayable aid than his more fortunate classmate.

An important form of non-repayable aid, the scholarship, is awarded in open competition and thus discriminates against students from impoverished backgrounds. The National Achievement Scholarship Program (Stalnaker, 1965) has been established for outstanding Negro students who participate in it on a voluntary basis. It is designed to be a temporary measure and to provide educational opportunity to these students until their minority group can compete on an equal footing with those in more favorable circumstances.

A survey of financial aid at Colorado State University found parental assistance to be the most important source of funds, with student employment in the community supplied more financial assistance in 1964 than loans, scholarships, and other awards (Miller, Ivey, & Goldstein, 1967, p. 600). Students seemed to prefer to seek employment rather than to borrow money. The following year, however, there appeared to be a shift in students' attitudes in favor of loans. The changing attitudes suggest that the most desirable com-

bination of forms of financial assistance varies, and appears to depend upon the individual's needs at a particular time.

CHAPTER III

Design and Procedure

Selection of the Sample

A table of random numbers was used to select a proportional stratified sample of one thousand students from a stratified population list of student identification numbers. The sample was stratified as to faculty, year of program, and sex, and consisted of undergraduates from the faculties of Education, Arts, Science, and Engineering who had received assistance for the 1967-68 academic term (Tables 2 and 3).

Data Collection

The data were obtained from the students' applications and the accompanying recommendation forms, and were recorded by sense marking answer sheets. They were transferred from the sheets to IBM cards by the Department of Education optical scanner.

Initially the data collected included certain selected items of the information used by the Students Assistance Board to make appraisals. As the configural model was developed, it became evident that some additional data were required. For example, the age item was originally designated as year of birth. For its use in the model, as one determinant of independence, it was given two levels: 21 or over and under 21, as of September 30, 1967.

TABLE 2

POPULATION AND STRATIFIED SAMPLE TOTALS AND PERCENTAGES FOR STUDENTS FROM THE FACULTIES OF EDUCATION, ARTS, SCIENCE, AND ENGINEERING RECEIVING FINANCIAL AID IN 1967-68

Faculty	Population						Sample					
	Male		Female		Total		Male		Female		Total	
	Number	% of faculty	Number	% of faculty	Number	% of population	Number	% of population	Number	% of population	Number	% of population
Education	614	37.6%	1017	62.4%	1631	44.5%	168	27.4%	277	27.2%	445	27.3%
Arts	448	50.7	436	49.3	884	24.1	122	27.2	119	27.5	241	27.3
Science	490	76.0	155	24.0	645	17.6	134	27.3	42	27.1	176	27.3
Engineering	503	99.1	4	0.9	507	13.8	137	27.2	1	25.0	138	27.2
Total	2055		1612		3667	100.0%	561		439		1000	

TABLE 3

DISTRIBUTION OF POPULATION TOTALS AND PERCENTAGES AND STRATIFIED SAMPLE TOTALS ACCORDING TO YEAR OF PROGRAM FOR STUDENTS FROM THE FACULTIES OF EDUCATION, ARTS, SCIENCE, AND ENGINEERING RECEIVING FINANCIAL AID IN 1967-68

		Population						Sample		
		Male		Female		Total		Male	Female	Total
Faculty	Year of program	Number	Percent of faculty	Number	Percent of faculty	Number	Percent of population			
Education	1	171	27.8%	330	32.4%	501	30.7%	47	90	137
	2	148	24.1	347	34.1	495	30.4	40	94	134
	3	157	25.6	212	20.9	369	22.6	43	58	101
	4	138	22.5	128	12.6	266	16.3	38	35	73
Total		614		1017		1631	100.0%	168	277	445
Arts	1	136	30.3	158	36.2	294	33.3	37	43	80
	2	149	33.3	130	29.8	297	33.6	41	36	77
	3	144	32.1	133	30.5	277	31.3	39	36	75
	4	19	4.2	15	3.5	34	38.5	5	4	9
Total		448	100.0%	436	100.0%	884	100.0%	122	119	241

TABLE 3 (continued)

Faculty	Year of program	Population						Sample		
		Male		Female		Total		Male	Female	Total
		Number	Percent of faculty	Number	Percent of faculty	Number	Percent of population			
Science	1	187	38.1%	79	51.0%	266	41.2%	51	21	72
	2	139	28.4	33	21.3	172	26.7	38	9	47
	3	118	24.1	29	18.7	147	22.8	32	8	40
	4	46	9.4	14	9.0	60	9.3	13	4	17
Total		490	100.0%	155	100.0%	645	100.0%	134	42	176
Engineering	1	169	33.6	4	100.0	173	34.1	46	1	47
	2	129	25.6	-	-	129	25.5	35	-	35
	3	102	20.3	-	-	102	20.1	28	-	28
	4	103	20.5	-	-	103	20.3	28	-	28
Total		503	100.0%	4	100.0%	507	100.0%	137	1	138

The further information required for the prediction models was recorded and key-punched on cards. A total of twenty items comprise the information used in the models (Appendix A).

The students' financial resources were observed to fall into three distinct classes:

1. A major source of assistance is government aid which is awarded on the basis of financial need. The repayable part of this assistance is provided by the Canada Student Loan and the Provincial Loan. The amount of the non-repayable part, the grant, depends upon the degree of influence of negative factors in a student's record. It was this government aid that provided the criterion variable of the study, the ratio of grant to total aid.

2. A second class of financial resource includes the student's contribution from any earnings that he may have and the contribution that his parents may make.

3. A third class of funds includes money from both public and private organizations. This class includes scholarships and bursaries, and is awarded primarily for academic achievement, and to a much lesser degree for other factors, including need.

Development of the Models

The Pattern of Configural Judgment

Before the hypotheses were investigated, a Students Assistance Board Assessor was interviewed and requested to rank certain factors (p.11) used in the assessment of finan-

cial aid with regard to their relative importance in determining need. (Table 4). The ranks were sought in an attempt to separate and weight the factors independently, thus providing structure for a model which might be compared with a multiple regression model by calculating Spearman's coefficient of rank correlation. It is emphasized that the assessor's appraisal uses the student's total pattern of factors with their interaction effects as well as the separate factors to determine the award.

It should be noted that factors related to need may be only incidental in determining what a student gets. For example, a rural student may need greater assistance, but it is not the home location factor that makes his award larger, but other factors in his application shared in common with other students; his father's income may be low and the required parental contribution reduced thereby.

The Multiple Regression Model

Assuming that the relationship between the criterion variable and the independent variables is linear and additive, a trial model was developed. An analysis was made using the grant:loan ratio as criterion and the variables included in the configural pattern as predictors. At the same time a ranking of the predictor variables was obtained by dropping each variable in turn from the model in order to determine the independent contribution of each predictor. The variables included in the model were able to account for

TABLE 4

ASSESSOR'S RANKING OF PERSONAL AND POLICY FACTORS IN TERMS OF THEIR RELATIVE IMPORTANCE TO A STUDENT'S FINANCIAL NEED

Kind of factor	Factor	Ranking
Personal	Sex	7
	Home location	1
Policy	Faculty	8
	Year of program	5
	Age	2
	Ratio of student contribution to student earnings	4
	Ratio of parental contribution to parental income	3
	Funds from other sources	6

only 14.5% of the variance in awards.

It became evident from a close examination of the data that several changes might be made in both criterion and predictor variables to permit the regression model to discriminate more closely. The three ratios included in the initial model -- the grant:loan ratio, the student earnings: savings ratio, and parental contribution:required contribution ratio -- were meaningless when the denominator became zero, as was occasionally the case. Eliminating the whole ratio when the denominator became zero would result in the loss of some information.

To provide more accurate prediction, new variables were structured and a new model was developed with the following form (Flathman, p. 2):

$$Y = A_0 + \overbrace{A_1X_1 + A_2X_2}^{\text{sex}} + \overbrace{A_3X_3 + A_4X_4 + A_5X_5}^{\text{home location}} + \overbrace{A_6X_6 + A_7X_7}^{\text{age}}$$

$$+ \overbrace{A_8X_8 + A_9X_9 + A_{10}X_{10} + A_{11}X_{11}}^{\text{faculty}} + \overbrace{A_{12}X_{12} + A_{13}X_{13} + A_{14}X_{14}}^{\text{year of program}}$$

$$+ \overbrace{A_{15}X_{15}} + \overbrace{A_{16}X_{16}}^{\text{student savings}} + \overbrace{A_{17}X_{17}}^{\text{student earnings}}$$

$$+ \overbrace{A_{18}X_{18}}^{\text{parental contribution}} + \overbrace{A_{19}X_{19}}^{\text{required parental contribution}}$$

$$+ \overbrace{A_{20}X_{20}}^{\text{student request}} + \overbrace{A_{21}X_{21}}^{\text{other sources}} + E$$

Y is the predicted criterion, X_1 - X_{21} are the predictor variables, A_0 is the constant, since it is the same for all subjects, and A_1 - A_{21} are the regression or beta weights associated with each predictor. The last term E is a residual.

The criterion variable was set up both as the ratio of grant plus loan and as the total grant plus loan. The second variable was introduced to provide a non-ratio and more general criterion. Student earnings, student savings, parental contribution, and required parental contribution became separate variables. The student request variable which was used in the configural model was added to the regression model. According to policy, when a scholarship is awarded, any grant for which the student is eligible is included with the scholarship to facilitate the payment of non-repayable aid in one form. The grant:total aid ratio is affected, for the grant normally given becomes part of the scholarship. It was decided to construct models with the new criterion variables which would both include and exclude the student request and scholarship variables.

In order to retain the stratification during the analyses, the sample was divided in two by selecting alternate subjects. Separate analyses were done for each group. Double cross-validation was done by applying the weights obtained from one group (e.g., the even-numbered) to the other group (e.g., the odd numbered), and vice versa.

Cross applying the weights in this manner gives two validations and two estimates of R^2[1] shrinkage (Kelly, Beggs, McNeil, Eichelberger & Lyon, pp. 194-195). Double cross validation prevents an over-estimate of the relationship among predictors and criteria. The cross-validated R^2, when compared with the R^2 using the group's own weights, will reveal the stability of the relationship.

The Configural Model

The configural model was visualized as a pattern of the components of policy and their associated procedure used in the distribution of financial aid by the Students Assistance Board. Application forms from students in each year of the four faculties were examined to determine the components and the nature of the procedures, and to define and clarify the relationships. The officials of the Students Assistance Board were particularly helpful in interpreting policy procedures.

The sample size had been tentatively set at 1000. Its selection required that it be representative of the population from which it was chosen, and have as many sub-groups as possible sufficiently large for a meaningful analysis. Here a knowledge of the structure of the student body was

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[1]The squared multiple correlation: the proportion of the variability of the dependent variable that is accounted for by the model, or alternatively, the predictive efficiency.

required in terms of the number of male and female students in each faculty and year of the programs. A table of stratified sample totals was prepared to make up the sample of 1000.

The selection of subjects was made by applying a list of random numbers to a stratified list of student identification numbers. To facilitate the handling of files, the identification numbers selected were listed in order according to year so that the files might be taken from an area in sequence with a minimum of movement. As the sample was selected, the information required for the model was recorded on sheets ruled for this purpose. Subjects were excluded on the basis of criteria listed on page 10.

The actual work of the model construction involved listing the various components and procedures, arranging them into small units of relationship, ordering these units into larger patterns, and finally producing the complete pattern or model.

A program was written by a staff member of the Division of Educational Research Services, Faculty of Education, for the application of the configural model. Trial runs to detect possible errors or omissions were made on selections of subjects from all years and faculties with a wide range of financial requirements. Two adjustments were made to the model, and in turn to the program.

The configural model, which is a pattern representing the administration of Students Assistance Board policy, is set up in the form of a flow chart (Figure 2). This policy is deterministic in nature, that is, values of the variables are specified, and each case assessed has one solution rather than a best solution (Appendix C). A serial multistage procedure is used: the problem is broken down into a series of smaller problems and decisions are made one at a time. The results of the solution of one of the smaller problems or stages becomes the basis for the calculation of the succeeding one (Nemhauser, 1967).

Structurally, the configural model makes use of three forms: ovals, rectangles, and diamonds which are connected by solid lines with arrows to indicate the order of selection and computation. The ovals designate variables for which information is available on IBM cards. Encircled numbers within the ovals are those of the columns on a subject's first card. Underlined numbers refer to the columns on the second card.

Rectangular boxes contain the calculation procedure of a stage of the process with decisions where applicable. Rectangular boxes made up of dashed lines contain calculations and decisions to be stored for later use. Binary questions are enclosed in diamond shaped boxes.

The pattern of the policy model begins with the basic criterion of dependence or independence. For the de-

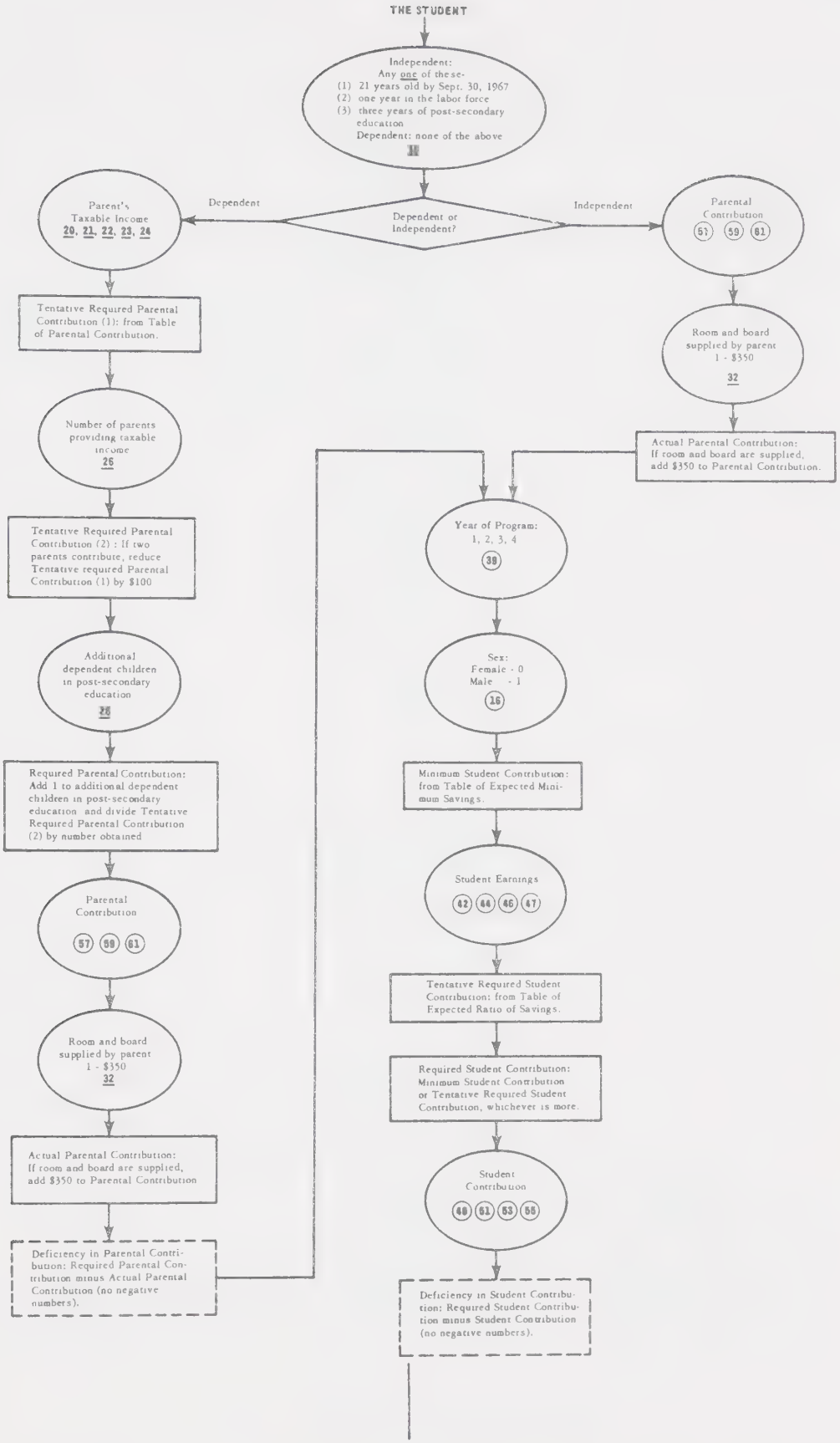

Figure 2. The Configural Model

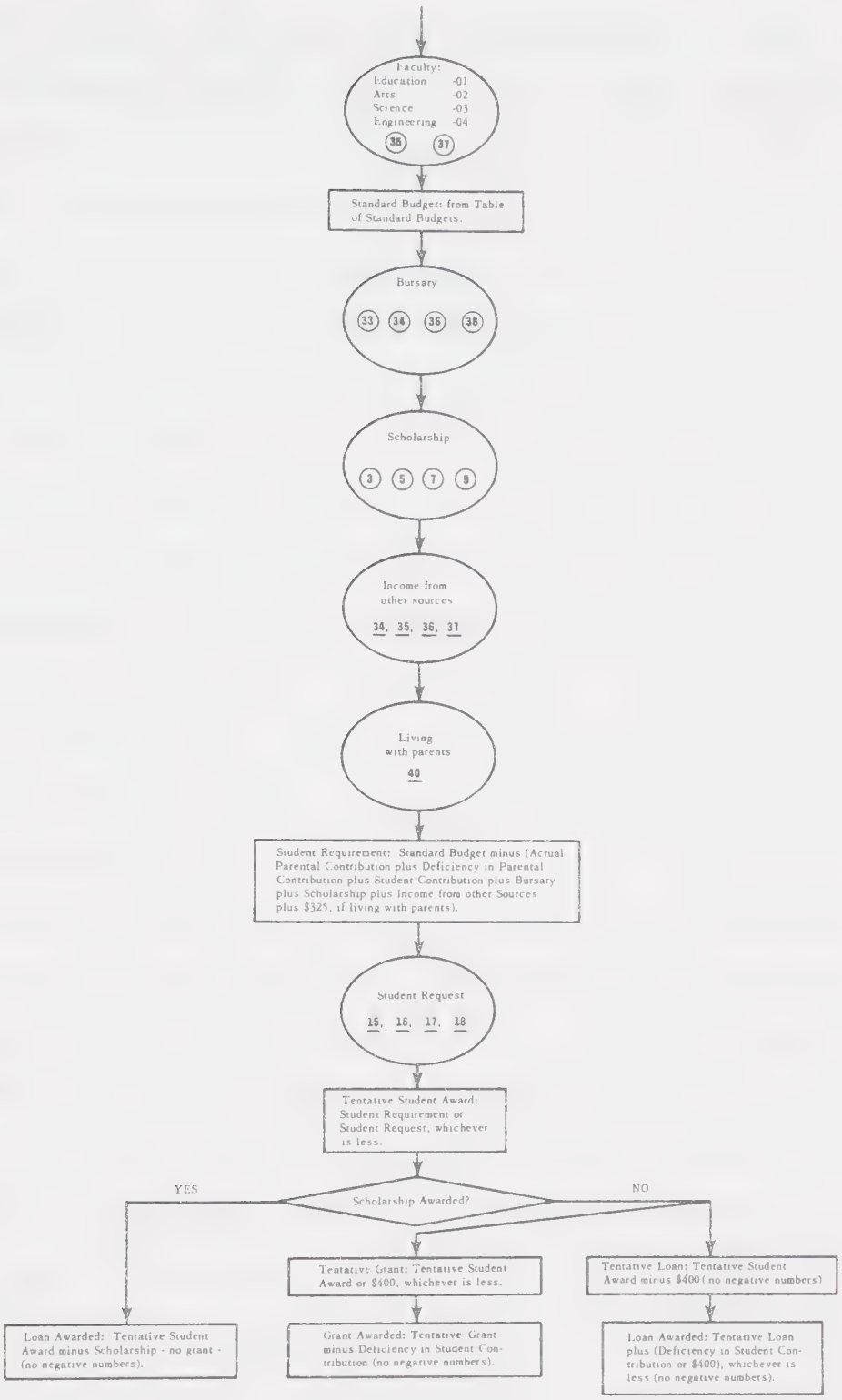

Figure 2. (continued)

pendent student, the steps in the calculation of both the required parental contribution and the actual parental contribution lead to the deficiency in parental contribution. From this stage the procedure follows the same route for both the dependent and independent student, through to the calculation of required and actual student contribution, and then to the deficiency in student contribution.

The student budget allowed, dependent upon faculty and year of program is selected next. The income from other sources is totalled, and finally the student requirement is determined by subtracting the sum of all sources of income, including adjustment for room and board, and deficiency in parental contribution, from the student's budget. The student requirement and the student request are compared and the smaller amount is awarded to the student. If he receives a scholarship, his grant is included with the scholarship and the balance of his award is in loan. With no scholarship, the award is divided between loan and grant contingent upon the adequacy of the student's contribution. The maximum grant of $400 is reduced by the amount the contribution is deficient, up to $400. This deficiency, up to $400, is added to the loan. The student award is thereby reduced by the amount of the deficiency in student contribution in excess of $400, and less than his requirement.

While the foregoing configural model should provide a fair assessment of most students' needs, some applications should not be handled mechanically. Factors determining

whether a student should receive special consideration in the awarding of his assistance are related to two main areas, student and parental contribution.

The amount a student is required to contribute toward his budget is either a specified minimum amount or a specified percentage of his summer earnings, whichever is more (Appendix B). When he fails to make this contribution, and reports reasons such as disability, unusual family responsibility, or lack of employment opportunity, his circumstances are investigated and appraised. The normal reduction in his grant for low contribution may be lessened or waived altogether. If, on the other hand, a low contribution is caused by reduced earnings because of holiday travel, or reduced savings because of extravagant spending, for example, the purchase of a car, the amount of grant or loan, or both may be reduced at the discretion of the assessor. The possession of fixed assets may also reduce the amount of the award.

A second factor affecting the assistance awarded is the amount of parental contribution. Parents of dependent students are required to contribute to the student's budget in accordance with a contribution table based upon the parent's taxable income (Appendix B). Normally a deficiency in the amount of the required parental contribution reduces the loan a student receives. Since the amount of taxable income declared is for the previous year, such things as

current business losses, crop failure, chronic illness of the parent, or excessive expenses for other dependents may reduce or waive the required parental contribution.

Another special condition affecting the student budget is living away from home when the institution being attended is in the home city. The additional expense incurred must be justified by providing evidence for its necessity.

A program was written for the application of the configural model. It was applied to the same halves as were used to produce the multiple regression equations. Both the entire sample and the sample excluding students with scholarships were analyzed for their predictive efficiency in obtaining the grant:loan ratio, the grant:grant plus loan ratio and the total aid. The squared correlation for the configural model is not based upon the accuracy of the appraisal, but rather on the accuracy of the ranking of the distribution of funds.

CHAPTER IV

Findings of the Study

The analysis was carried out by the Division of Educational Research Services, Faculty of Education, University of Alberta. Each hypothesis is restated followed by a report and interpretation of the findings of the analyses.

It is assumed that the judgments of the Students Assistance Board assessors are valid (p. 4), and may therefore be used as a basis for the evaluation of the models. This assumption does not rule out the possibility of a discrepancy between the strict application of policy and the assessor's more subjective appraisal.

Analysis of the Multiple Regression Model

Hypothesis 1. There is a high correlation between the judgments of the multiple regression equation and the judgments of the Students Assistance Board assessors.

Double cross validation showed the model to be very stable with "shrinkage" ranging from 2.00% to 2.92% (Table 5). The smallest amount of shrinkage was found in the prediction of total aid, when weights developed on the sample of even numbered subjects and applied to odd-numbered subjects predicted .7288 - .7088 = 2.00% less than the original prediction for odd-numbered subjects. The largest amount of shrinkage was observed in the prediction of the ratio of

TABLE 5

PREDICTIVE EFFICIENCY OF THE MULTIPLE REGRESSION EQUATION

Criterion	Sample	Total subjects	Alternate subjects (odd)	Alternate subjects (even)	Double cross-validation	
					Odd predicting even	Even predicting odd
Grant: Total aid	Total cases	.4531	.4597	.4572	.4366	.4383
Grant: Total aid	Omit student request	.3580	.3669	.3631	.3378	.3377
Grant: Total aid	Omit scholarship	.4240	.4309	.4295	.4090	.4077
Total aid	Total cases	.7493	.7288	.7841	.7611	.7088
Total aid	Omit student request	.5346	.5574	.5219	.4986	.5330
Total aid	Omit scholarship	.7337	.7054	.7834	.7550	.6816

grant:total aid. Weights developed on the even-numbered group and applied to the odd-numbered group predicted .3669 - .3377 = 2.92% less than the original prediction for even numbered subjects.

The model could predict only 45.31% of the criterion in ratio form, but its predictive efficiency increased to 74.93% for total aid. Since the obtained levels of prediction are not sufficiently high to meet the required level set, Hypothesis 1 must be rejected.

The analysis showed the student request to be by far the best predictor of all the variables. The predictive efficiency of the ratio model (grant:total aid) was lowered 9.50%, and the model predicting total aid 21.47%, when the student request variable was removed. Omitting the scholarship cases from the sample somewhat reduced the predictability of both the grant:total aid and the total aid equations.

The substantially lower prediction of the grant:total aid criterion would appear to be in part due to the structure of the criterion, and in part to the nature of the subjective appraisal. Since grants tend to be awarded in round numbers, and because they are non-repayable, they are rounded off to the next lower figure, with the result that there may be a number of grants somewhat smaller than the policy would allow. These lowered grants would materially reduce the ratio of the award. The possibility that some of

the variables in the regression model are not linear and directly additive may also affect the predictability of the model.

Comparison of Multiple Regression and Configural Judgment

Hypothesis 2. There is a significant association, at the .05 level, between the predictive efficiency of the multiple regression equation and that of clinical judgment.

Spearman's coefficient of rank correlation (Ferguson, 1966) was calculated to determine the association between the assessor's ranking of the predictors and the ranks obtained by the multiple regression equation (Table 6). The correlation coefficient obtained, 0.476, approaches but does not attain significance at the .05 level. Because the number of variables is small (N = 8), the correlation coefficient must be of a very substantial size (equal to or greater than 0.643) before the association may be considered significant. Hypothesis 2 is therefore rejected.

An inspection of the differences in the ranking of variables between the assessor and the multiple regression equation revealed fairly close agreement on all but one variable, the student's funds from other sources. The equation ranked it first, while the assessor considered it sixth in importance.

Analysis of the Configural Model

Hypothesis 3. There is a high correlation between the judgments of the configural model and the judgments of the

TABLE 6

RANKING OF PREDICTOR VARIABLES BY A STUDENTS ASSISTANCE BOARD ASSESSOR AND THE MULTIPLE REGRESSION EQUATION

Predictor variable	Ranking by assessor	Ranking by equation
Sex	7	7
Home location	1	4
Faculty	8	8
Year of program	5	6
Age	2	3
Ratio of student contribution to student earnings	4	2
Ratio of parental contribution to parental income	3	5
Funds from other sources	6	1

Students Assistance Board assessors.

Table 7 outlines the relative efficiency of the configural model in predicting the grant:total aid ratio, and total aid. The other criterion variables, in addition to the original grant:total aid ratio, were added and examined to determine any trends in the predictability of the model.

The grant:total aid ratio prediction was 43.82% for odd-numbered subjects and 2.75% lower for even-numbered subjects. When the scholarship cases were removed from the sample, the prediction of the grant:total aid ratio dropped to 34.18% for even-numbered subjects. The best prediction was made for total aid, including all cases. Odd-numbered subjects had their total aid predicted 71.97% of the time. Even-numbered subjects were higher with 75.37% prediction. The grant:loan ratio had a high prediction of 52.25% for even-numbered subjects and 45.28% for odd-numbered subjects. Since the predictive efficiency of the configural model failed to attain the required level, Hypothesis 3 is rejected.

Comparison of the Multiple Regression and the Configural Models

Hypothesis 4. There is a significant difference between the predictive efficiency of the configural model and that of the multiple regression equation.

The multiple regression model, through the use of the least squares method, develops a set of regression

TABLE 7

PREDICTIVE EFFICIENCY OF THE CONFIGURAL MODEL

Criterion	Sample	Alternate subjects (odd)	Alternate subjects (even)
Grant: Total aid	Total cases	.4382	.4107
Grant: Total aid	Omit scholarship	.3867	.3418
Total aid	Total cases	.7197	.7537
Total aid	Omit scholarship	.7042	.7404

weights that will result in the least error of prediction. It attempts to predict the criterion using the variables that appear to make up the policy. It would seem that the variables here were well selected and structured, for the multiple regression model is very stable.

The configural model is a direct application of policy and fluctuates in predictive efficiency between groups (Table 7). For example, the prediction of the grant:loan ratio with scholarship cases removed from the sample is only 22.04% for the odd-numbered subjects and increases to 35.94% for even-numbered subjects, a difference of 13.90%. The smallest difference between groups was observed in the prediction of the grant:total aid ratio using all of the cases. Here the difference in prediction was 2.75%.

The predictive efficiency between models (Table 8) must be considered in terms of the somewhat different criteria that are measured and the different techniques used for measuring them. The multiple regression model was developed with data obtained from the actual administration of policy. Its predictive efficiency is the degree to which the model can predict the kind and amount of assistance that was awarded when policy was put into practice. The configural model, by contrast, is a pattern of policy procedures designed so that assistance may be calculated as prescribed by policy. Its predictive efficiency is an in-

TABLE 8

DIFFERENCES IN PREDICTIVE EFFICIENCY BETWEEN THE MULTIPLE REGRESSION MODEL AND THE CONFIGURAL MODEL

Criterion	Sample	Model		Difference in predictive efficiency
		Multiple regression	Configural	Multiple regression minus configural
Grant:total aid	Total cases (odd-numbered)	.4597	.4382	.0215
	(even-numbered)	.4572	.4107	.0465
Grant:total aid	Omit scholarship (odd-numbered)	.4309	.3867	.0442
	(even-numbered)	.4295	.3418	.0877
Total aid	Total cases (odd-numbered)	.7288	.7197	.0091
	(even-numbered)	.7841	.7537	.0304
Total aid	Omit scholarship (odd-numbered)	.7054	.7042	.0012
	(even-numbered)	.7834	.7404	.0430

dication of how closely the assessors have followed the policy in distributing assistance.

The least squares method of the multiple regression equation is based upon group means and uses a maximum amount of information from the sample. It is thus a powerful technique for measuring correlation. The measure of correlation based upon ranks used for the configural model deals with somewhat less information. It correlates the ranks of the awards made by the assessors with those made by the configural model, and is not concerned with the differences in the amounts of the awards.

The differences in predictive efficiency between models range from 8.77% for the prediction of the grant:total aid ratio to a low of 0.12% for the prediction of total aid, and have a mean of 3.55%. Since the mean difference in predictive efficiency between the models did not exceed the conventional .05 level of significance, Hypothesis 4 is rejected. Had a technique that handled as much information as that for the multiple regression model been used for measuring the predictive efficiency of the configural model, it seems possible that the predictive efficiency for the configural model would have been significantly higher.

CHAPTER V

Summary, Conclusions, and Recommendations

Although the regression model was able to predict somewhat more efficiently than the configural model, it can not be used satisfactorily to administer policy that is subject to change. Each change in policy would require the development of new regression weights and possibly new variables, and these can only be developed by using data containing the variables. The configural model may be readily modified to adopt current policy changes as soon as they are made. Many additions or deletions may be made without affecting the basic structure. The configural model would thus appear to be appropriate for assessing applications for financial aid efficiently and well.

It appears that neither the configural model nor the multiple regression model was able to predict efficiently enough for the groups selected to warrant their general use. It is possible that some subjective aspect of the appraisal not noted may have influenced the amounts of aid awarded, and consequently the efficiency of the models.

In the event that an attempt may at some time be made to deal with some applications mechanically, the following suggestions are offered:

1. Application forms should be structured for ease in recording of data with a close differentia-

tion of the criteria used in making decisions.

2. Relevant data on the forms should include information that clearly indicates if an application requires special consideration.
3. The program written to make the assessment should be designed to reject those applications requiring special consideration in order to ensure a subjective appraisal.

On the basis of the findings of the present study, it would seem that the mechanical appraisal of applications could be feasible, but only within a predetermined and well-defined structure of policy, format, and programming.

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APPENDICES

APPENDIX A

LAYOUT FOR IBM CARDS

Card	Columns	Information	Code
1	3,5,7,9	Scholarship	$
1	12,14,15,17	Grant	$
1	16	Sex	0 - female 1 - male
1	18	Home location	0 - city 1 - town 2 - rural
1	19,20,22,24	Canada loan	$
1	26,27,29,30	Provincial loan	$
1	33,34,36,38	Bursary	$
1	37	Faculty	1 - Education 2 - Arts 3 - Science 4 - Engineering
1	39	Year of program	1, 2, 3, 4
1	42,44,46,47	Student's earnings	$
1	49,51,53,55	Student's savings	$
1	57,59,61	Parental contribution	$
2	15,16,17,18	Student's request	$
2	20,21,22,23,24	Parents' taxable income	$
2	26	Number of parents providing income	1, 2, or blank
2	28	Number of dependent siblings in post-secondary education	1, 2, 3, or blank
2	30	Age	1 - 21 years or over Blank - under 21 years

APPENDIX A (continued)

Card	Columns	Information	Code
2	30	Independence	1 - 21 years or over 2 - one year in labor force 3 - three years of post-secondary education
2	32	Parental contribution of room and board	1 - $350
2	34,35,36,37	Income from miscellaneous sources	$
1 & 2	2,4,6,8,10,11, 13	Student identification number on both cards	
1 & 2	80	Sequence number of cards	1 or 2

APPENDIX B

INFORMATION USED FOR THE CONFIGURAL MODEL PROGRAM

EXPECTED MINIMUM SAVINGS FROM SUMMER EARNINGS

	Female	Male
Entering 1st year	$100	$200
2nd to 4th year	250	500

Reduce grant or scholarship by the amount that savings are less than table.

EXPECTED RATIO OF SAVINGS TO SUMMER EARNINGS

Up to $400	-	30%
$401 to $900	-	40%
$901 to $1400	-	50%
Over $1401	-	60%

Reduce grant or scholarship by the amount that savings are less than the amount expected.

THE TABLE OF STANDARD BUDGETS

Faculty	1st year	2nd year	3rd year	4th year
Education	$1650	$1700	$1650	$1650
Arts	1650	1650	1650	1650
Science	1700	1700	1700	1700
Engineering	1790	1750	1750	1750

THE TABLE OF PARENTAL CONTRIBUTION

Taxable Income $	Contribution $	Taxable Income $	Contribution $	Taxable Income $	Contribution $
200	20	3800	390	7400	940
400	40	4000	410	7600	980
600	50	4200	440	7800	1010
800	70	4400	460	8000	1050
1000	90	4600	490	8200	1090
1200	110	4800	520	8400	1130
1400	130	5000	550	8600	1170
1600	150	5200	580	8800	1210
1800	170	5400	610	9000	1250
2000	190	5600	640	9200	1290
2200	210	5800	670	9400	1330
2400	240	6000	700	9600	1370
2600	260	6200	730	9800	1410
2800	290	6400	770	10000	1450
3000	310	6600	800		
3200	330	6800	840		
3400	350	7000	870		
3600	370	7200	910		

Round taxable income to the nearest $100.00 and interpolate contribution where necessary.

APPENDIX C

SAMPLE OF TWO APPLICATIONS FOR ASSISTANCE AND THEIR APPRAISAL

Student A

Student A is male and was born on January 14, 1943. He lives at home with his parents who provide him with free room and board while he attends University. He is a fourth-year student in the faculty of Science. Between sessions he earned $1900 and has saved $300 toward his education expenses. A relative gave him $125 to assist with his expenses. In his application he requests $900 in assistance.

Student B

Student B is female and was born on March 22, 1949. During the past year both of her parents worked and earned a total of $6400 in taxable income. A twenty-year-old sister is also attending University and is considered a dependent of her parents. Student B is taking her first year of Education. During the summer she earned a total of $500 and saved $250 toward her education expenses. She has been granted a bursary of $200 by a local school division. She requests $700 in assistance.

APPENDIX C (continued)

Variables	Student A		Student B	
	Information	Solution or Decision	Information	Solution or Decision
Birthdate	Jan., 1943	Independent	Mar., 1949	Dependent
Parent's Taxable Income			$6400	
Tentative Required Parental Contribution(1)			from table	$770
Number of parents providing income			2	
Tentative Required Parental Contribution(2)				$670
Additional dependents in post-secondary education			1	
Required Parental Contribution				$335
Parental Contribution			$200	
Room and board supplied by parent	Yes		No	
Actual Parental Contribution		$350		$200
Deficiency in Parental Contribution				$135
Year of Program	4		1	
Sex	Male		Female	
Minimum Student Contribution	from table	$500	from table	$100
Student Earnings	$1900		$500	
Tentative Required Student Contribution	from table	$1140	from table	$200

APPENDIX C (continued)

Variables	Student A		Student B	
	Information	Solution or Decision	Information	Solution or Decision
Required Student Contribution		$1140		$200
Student Contribution	$300		$250	
Deficiency in Student Contribution		$840		Nil
Faculty	Science		Education	
Standard Budget	from table	$1700	from table	$1650
Bursary	Nil		$200	
Scholarship	Nil		Nil	
Income from Other Sources	$125		Nil	
Living with Parents	Yes		No	
Student Requirement		$600		$735
Student Request	$900		$700	
Tentative Student Award		$600		$700
Scholarship	No		No	
Tentative Grant	$400		$400	
Grant Awarded		Nil		$400
Loan Awarded		$400		$300